US009471141B1

(12) **United States Patent**
Noble et al.

(10) **Patent No.: US 9,471,141 B1**
(45) **Date of Patent: Oct. 18, 2016**

(54) **CONTEXT-AWARE NOTIFICATIONS**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/792,496**

(22) Filed: **Jul. 6, 2015**

Related U.S. Application Data

(63) Continuation of application No. 13/867,988, filed on Apr. 22, 2013, now Pat. No. 9,075,435.

(51) **Int. Cl.**
G09G 5/00 (2006.01)
G06F 3/01 (2006.01)

(52) **U.S. Cl.**
CPC ***G06F 3/013*** (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

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(74) *Attorney, Agent, or Firm* — Polsinelli LLP

(57) **ABSTRACT**

Systems and approaches are provided for presenting incoming notifications to a computing device based on a determined context of the computing device. Various sensors of the device can be used to determine the context of the device with respect to a user, the state of the device itself, or the context of the device with respect to the environment in which the device is situated. The user can then be informed of received notifications in a manner likely to get the user's attention while not being overly obtrusive to the user or others within the vicinity of the user.

20 Claims, 8 Drawing Sheets

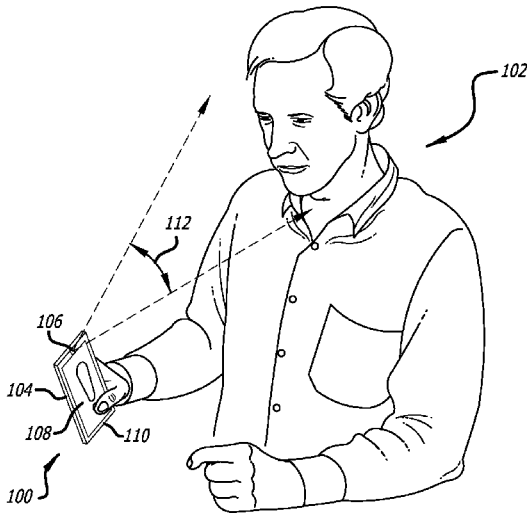
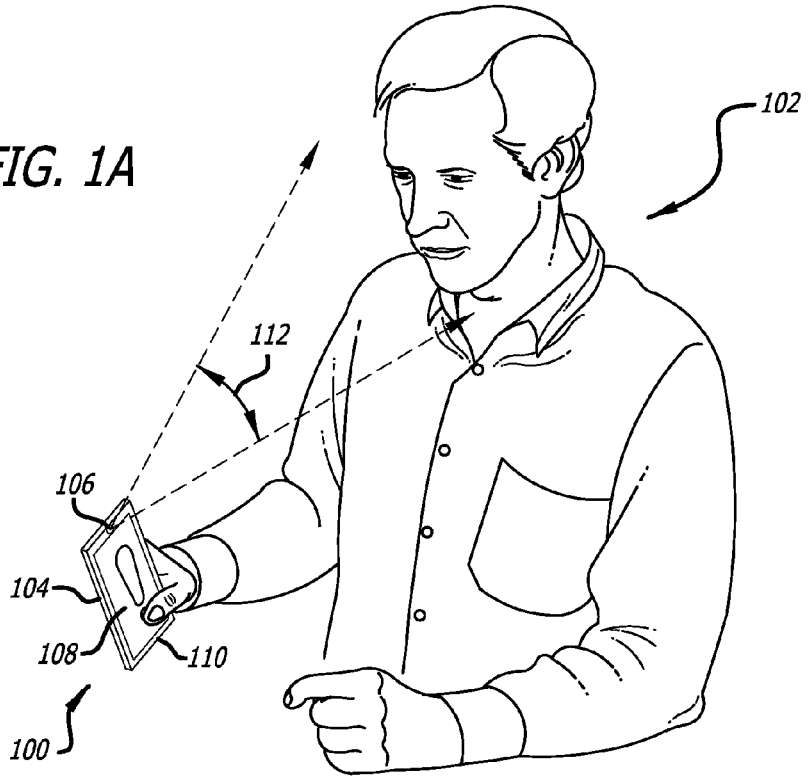


FIG. 1A



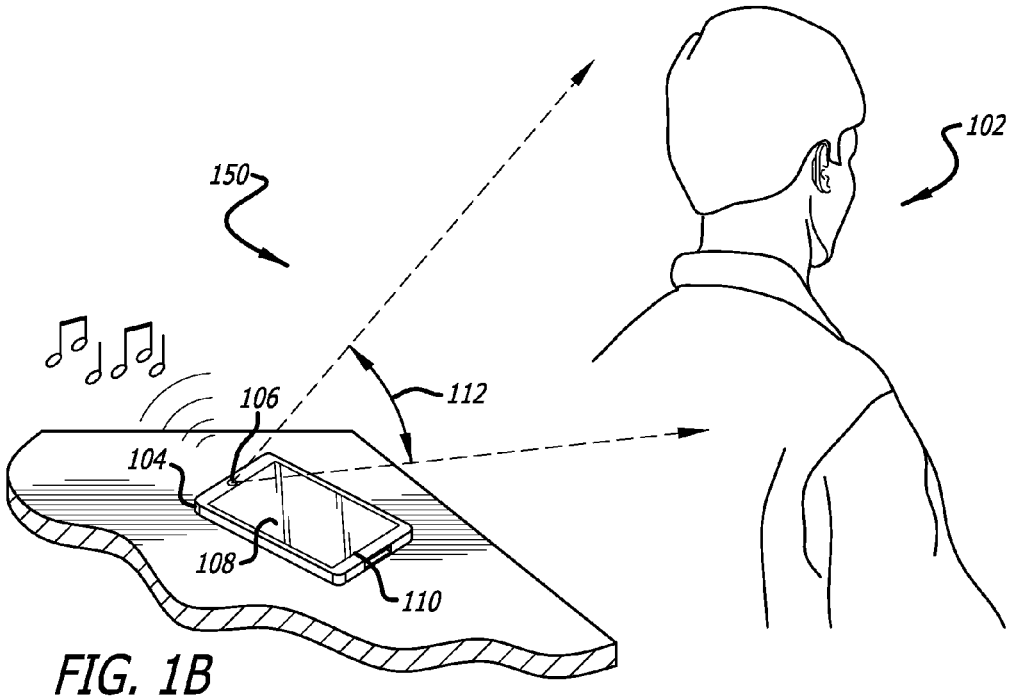
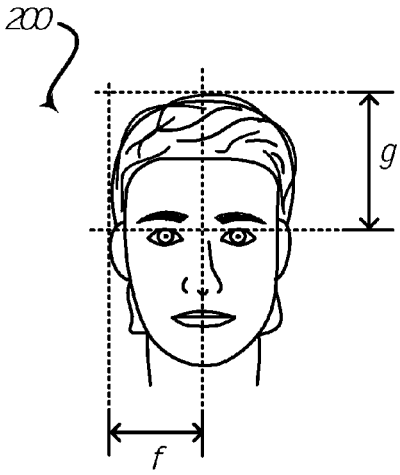


FIG. 1B



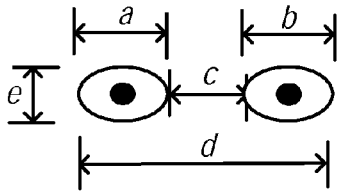
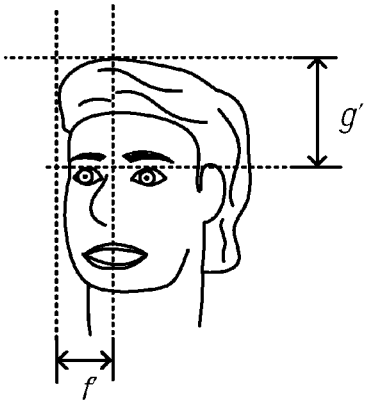


FIG. 2A



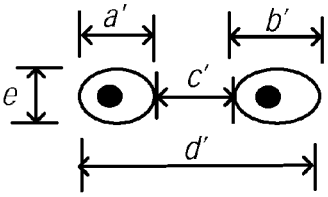
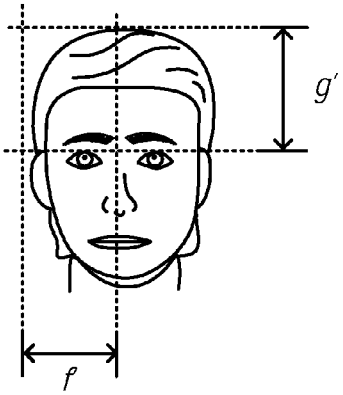


FIG. 2B



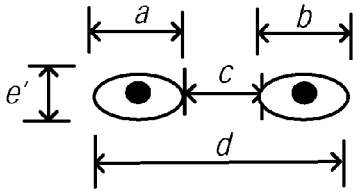


FIG. 2C

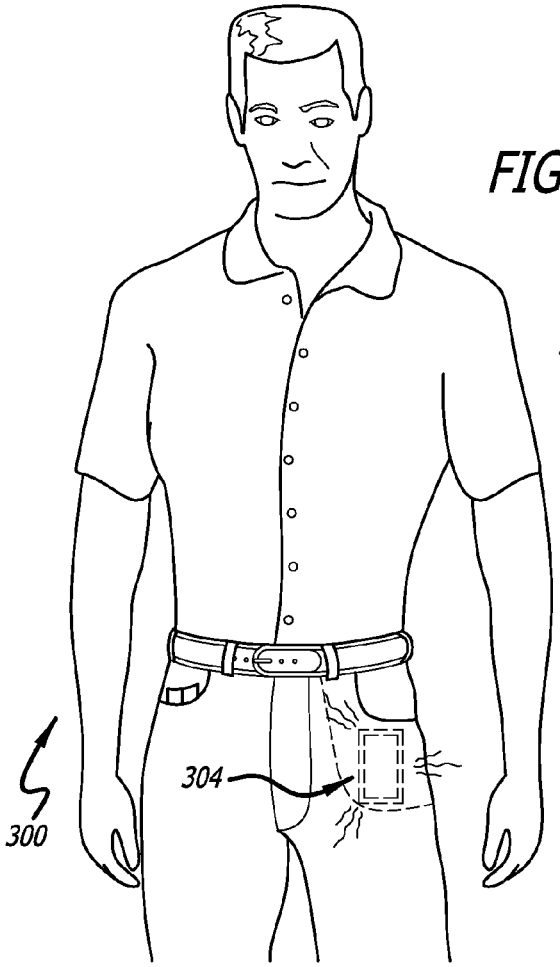


FIG. 3A

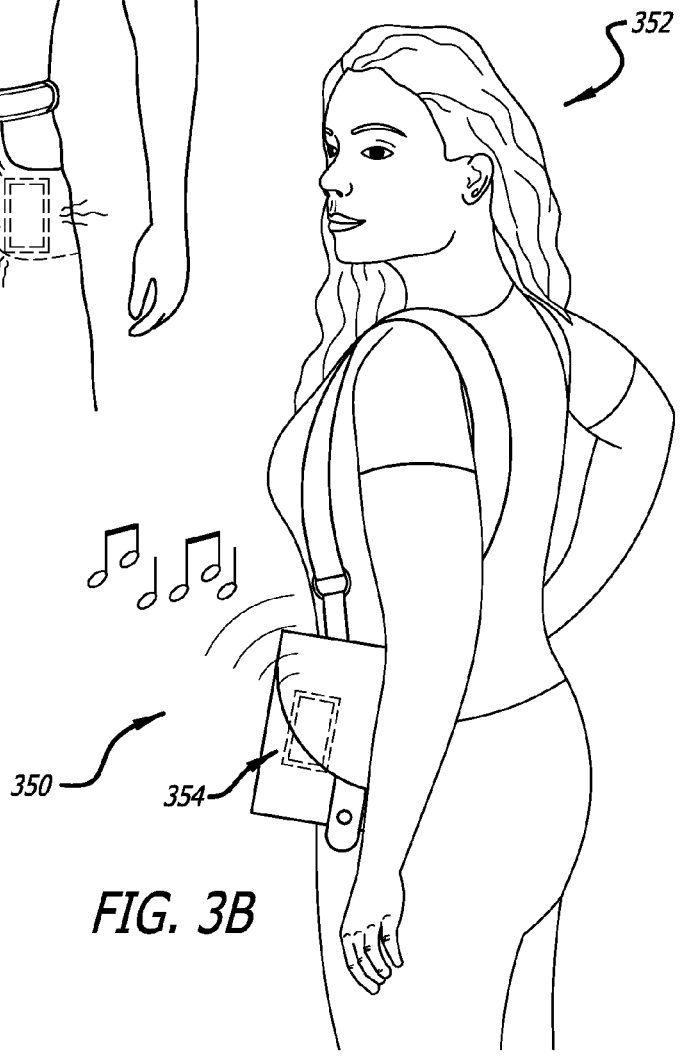


FIG. 3B

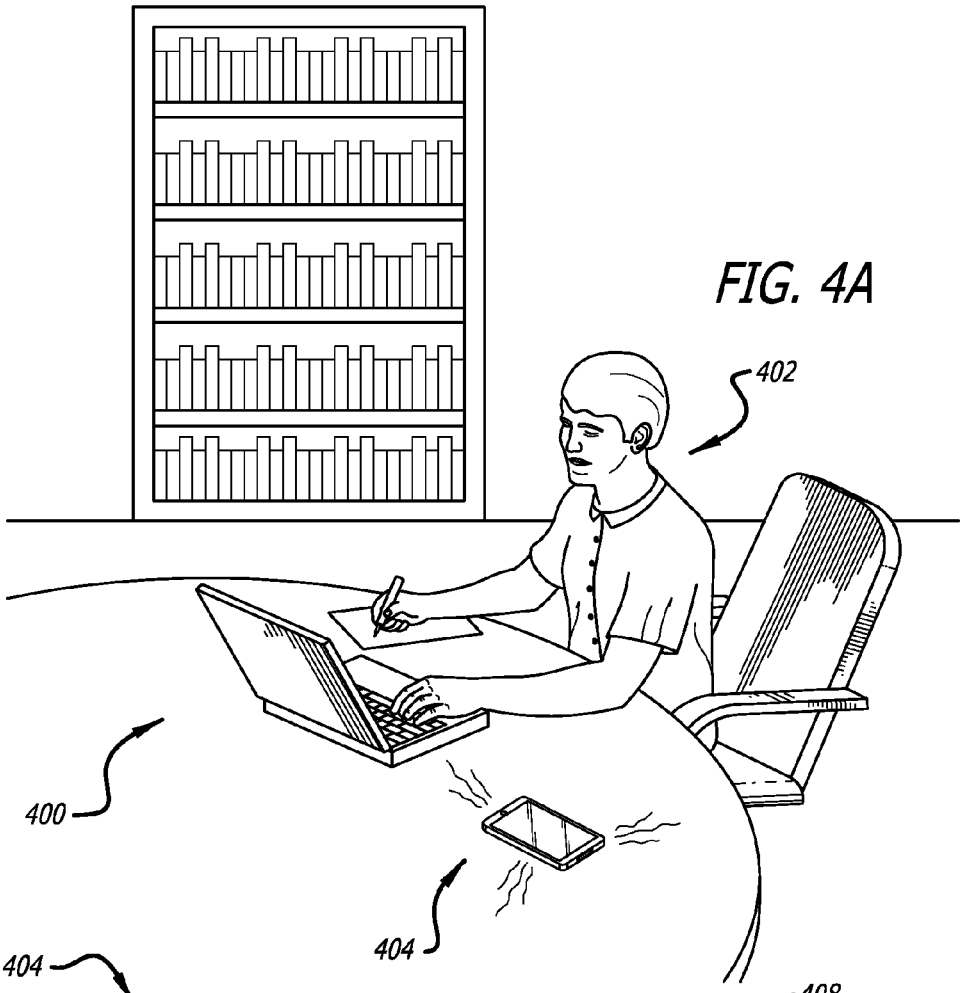

402
400
404
404

FIG. 4A

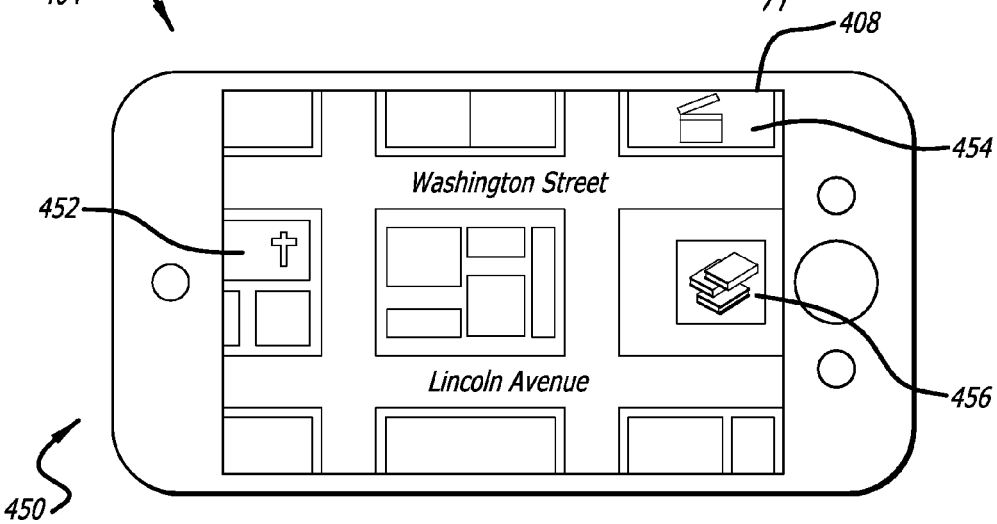

408
454
Washington Street
452
Lincoln Avenue
456
450

FIG. 4B

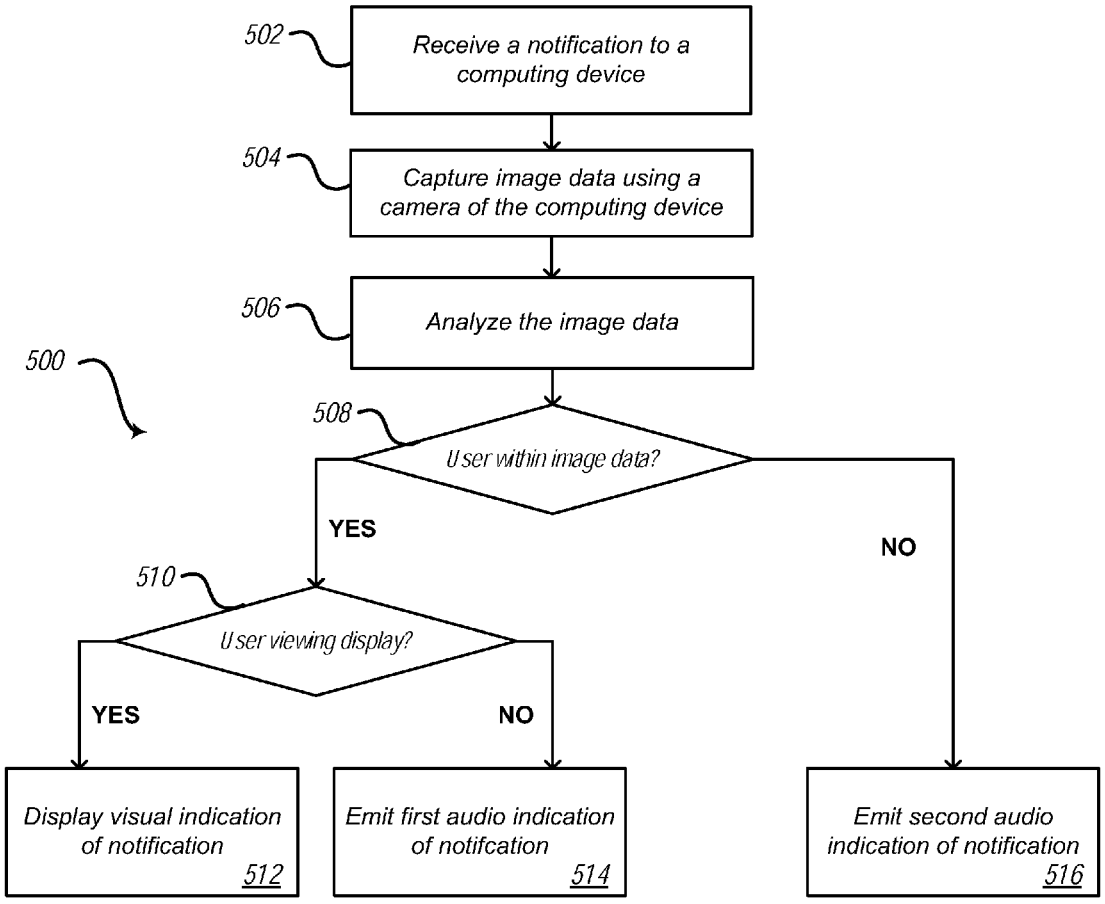

502
Receive a notification to a computing device
504
Capture image data using a camera of the computing device
506
Analyze the image data
500
508
User within image data?
YES
NO
510
User viewing display?
YES
NO
Display visual indication of notification
512
Emit first audio indication of notifcation
514
Emit second audio indication of notification
516

FIG. 5

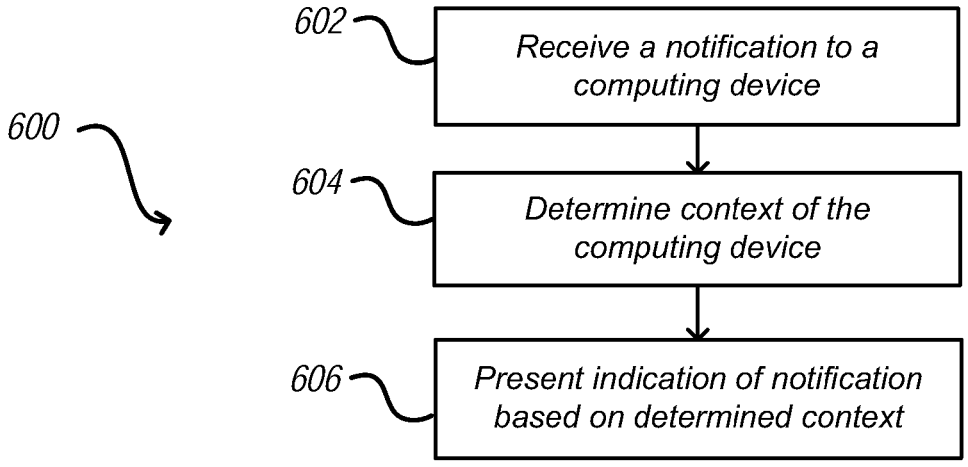

600
602
Receive a notification to a computing device
604
Determine context of the computing device
606
Present indication of notification based on determined context

FIG. 6A

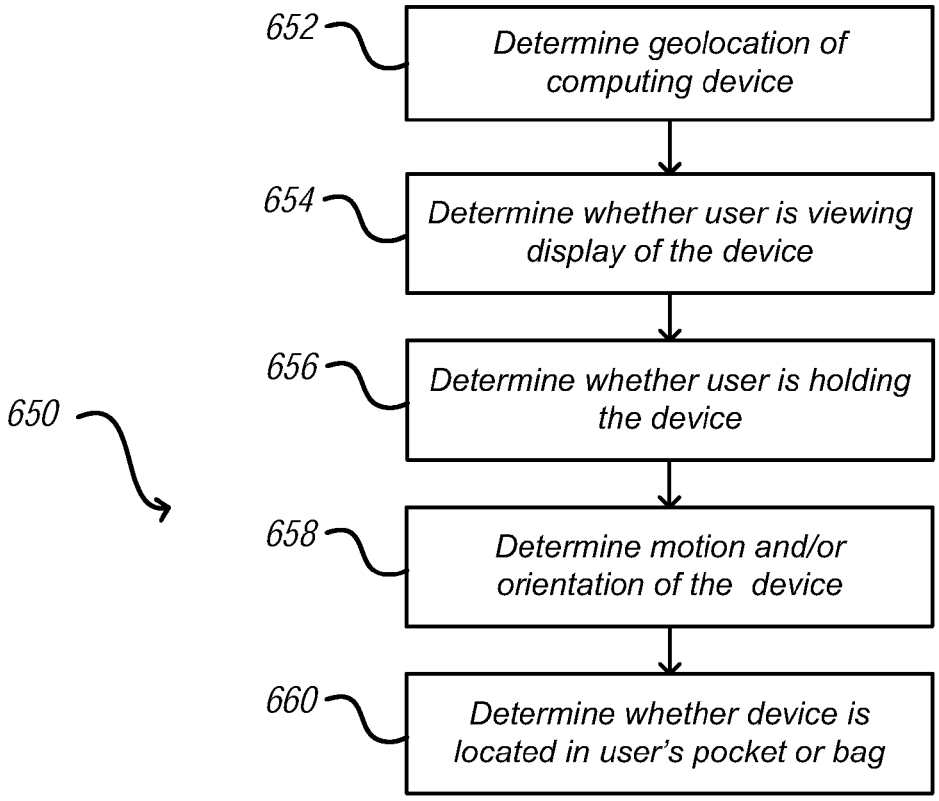

650
652
Determine geolocation of computing device
654
Determine whether user is viewing display of the device
656
Determine whether user is holding the device
658
Determine motion and/or orientation of the device
660
Determine whether device is located in user's pocket or bag

FIG. 6B

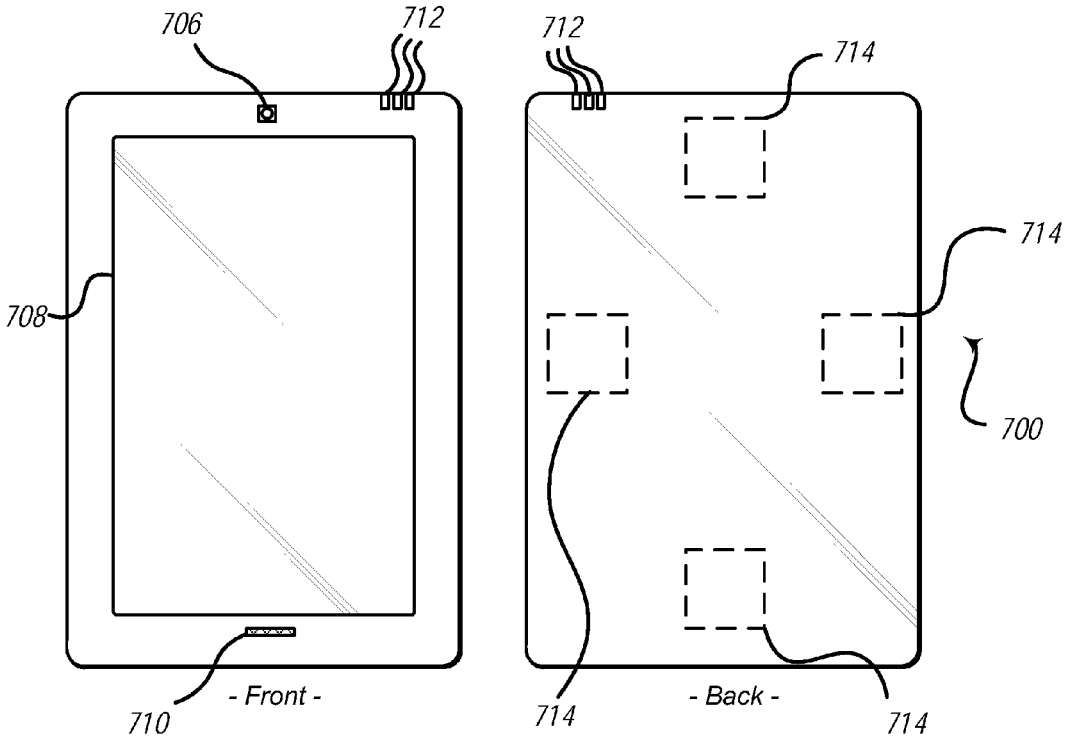

706
712
712
714
714
708
700
710
- Front -
714
- Back -
714

FIG. 7

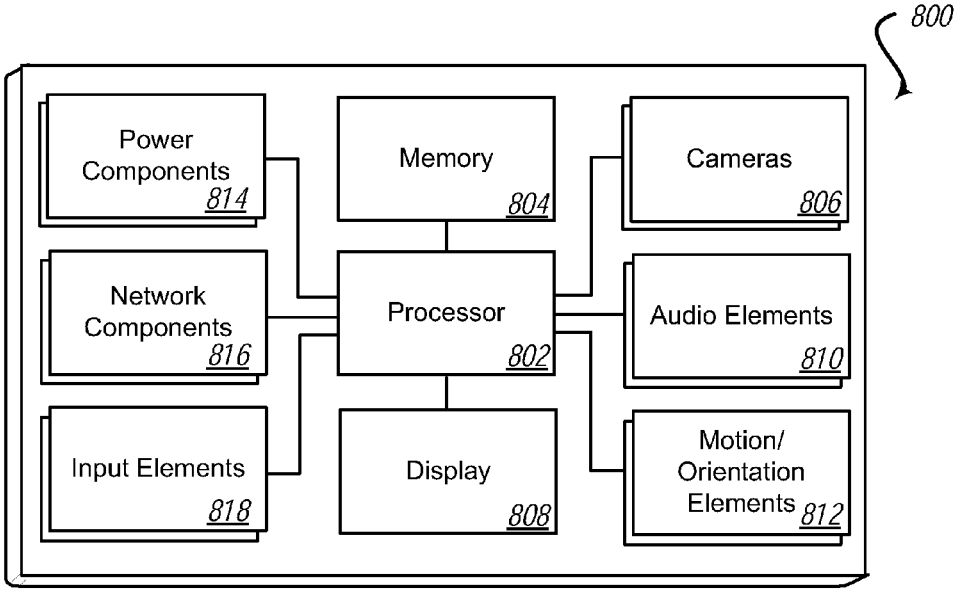

800
Power Components 814
Memory 804
Cameras 806
Network Components 816
Processor 802
Audio Elements 810
Input Elements 818
Display 808
Motion/ Orientation Elements 812

FIG. 8

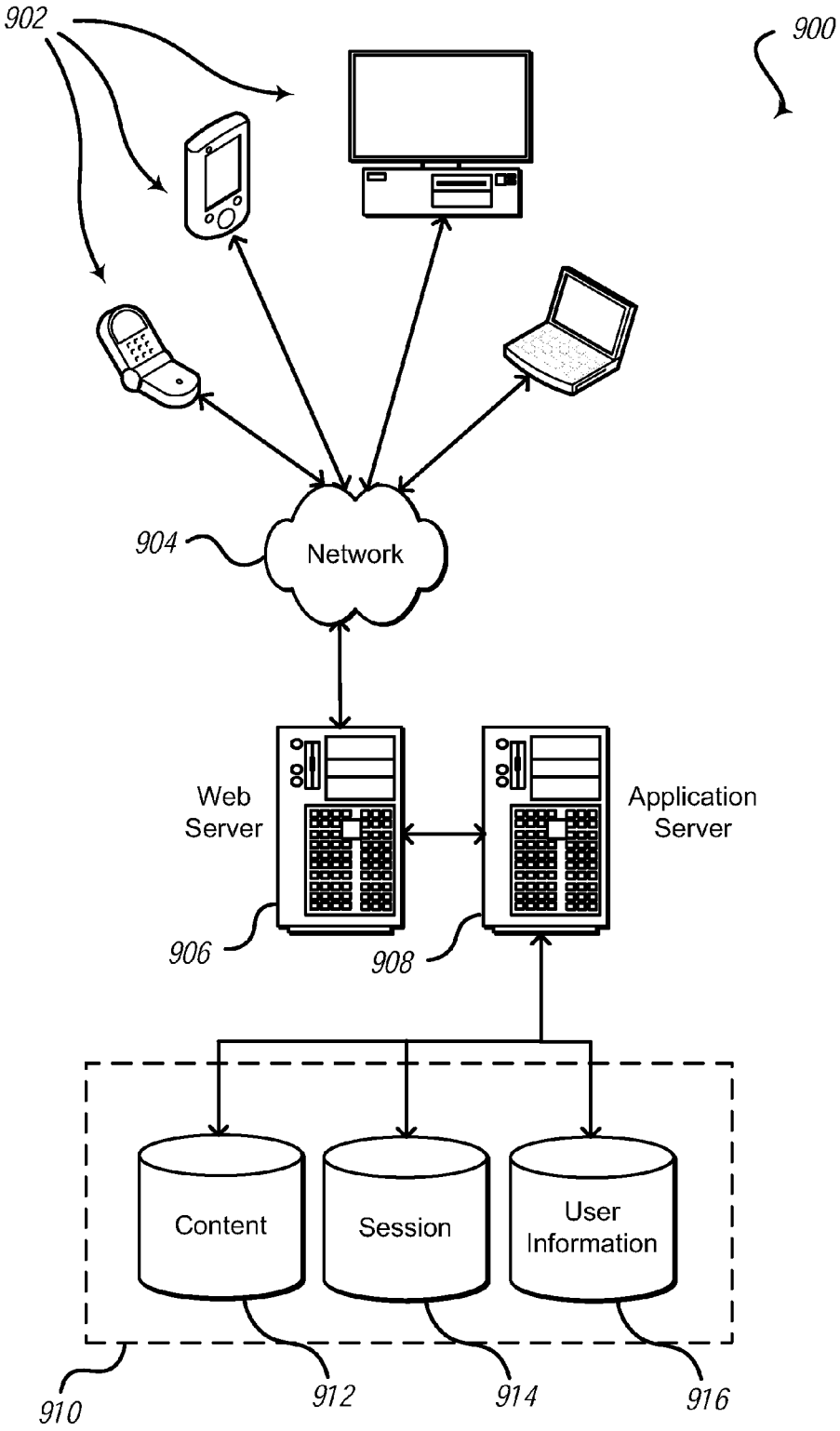

902
900
904
Network
Web
Server
Application
Server
906
908
Content
Session
User
Information
910
912
914
916

FIG. 9

CONTEXT-AWARE NOTIFICATIONS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. application Ser. No. 13/867,988, filed Apr. 22, 2013, entitled "CONTEXT-AWARE NOTIFICATIONS"; which is hereby expressly incorporated herein by reference in its entirety.

BACKGROUND

An important feature of many personal computing devices, such as laptop computers, tablets, or smartphones, is the capability of running multiple user applications, often simultaneously. For example, a user may read an electronic book, check her calendar, map a route to a particular destination, take photographs, or play a video game from her personal electronic device. At the same time, the user may receive an email, text message, or social network status or be notified of breaking news, a weather update, traffic congestion, or a sports score from her device. Many user applications operating on personal computing devices are configured to provide such notifications, updates, alerts, messages, and similar communications as unobtrusively as possible because the user may find it annoying and/or frustrating if these communications repeatedly diverted the user from another user application that is the focus of the user's attention. However, there may be occasions that the user will miss a critical notification that is presented in too subtle of a manner or mode. In some devices, the user may configure the device and/or the user application to present notifications more overtly. Although the user may be less likely to miss notifications as a result, such approaches can also have its drawbacks, such as disturbing others in the vicinity of the device. In other circumstances, a user configuration may be equally as ineffective in attracting the user's attention as default settings, such as the user configuring the device and/or user application to emit a ringtone or other audio and the user being situated in a noisy environment when her device receives a notification.

BRIEF DESCRIPTION OF THE DRAWINGS

Various embodiments in accordance with the present disclosure will be described with reference to the drawings, in which:

FIGS. **1**A and **1**B illustrate examples of a personal computing device receiving a notification as a user is respectively viewing a display element of the device and not viewing the display element in accordance with an embodiment;

FIGS. **2**A, **2**B, and **2**C illustrate examples of ways to determine gaze direction that can be utilized in accordance with various embodiments;

FIGS. **3**A and **3**B illustrate examples of a personal computing device receiving a notification as the device is respectively located in a first user's pocket and a second user's purse in accordance with an embodiment;

FIGS. **4**A and **4**B illustrate examples of a personal computing device receiving notifications based on the device's location in accordance with an embodiment;

FIG. **5** illustrates an example process for presenting context-aware notifications in accordance with an embodiment;

FIGS. **6**A and **6**B illustrate example processes for presenting context-aware notifications in accordance with various embodiments;

FIG. **7** illustrates an example of a computing device that can be used in accordance with various embodiments;

FIG. **8** illustrates an example configuration of components of a computing device such as that illustrated in FIG. **7**; and

FIG. **9** illustrates an example environment in which various embodiments can be implemented.

DETAILED DESCRIPTION

Systems and methods in accordance with various embodiments of the present disclosure may overcome one or more of the aforementioned and other deficiencies experienced in conventional approaches for presenting information to a user of a computing device. In particular, various embodiments involve receiving a notification (also sometimes referred to as an alert or update) to a computing device, determining a current context of the computing device, and presenting an indication of the notification to the user according to the device context. For example, a camera of a computing device can be used to capture image data to determine that the user is facing a display element of the computing device and the computing device can present a graphical element on the display element to indicate to the user receipt of the notification. If captured image data indicates that the user is not within the vicinity of the device, a speaker of the device may be activated to generate a ringtone, voice indicator, or other audio signal informing the user of the notification. If the computing device detects the presence of the user within the vicinity of the device but determines that the user is not facing the device, the device may generate a ringtone or other audio of a low or intermediate volume and/or vibrate to draw the user's attention to the received notification.

In various embodiments, data captured by one or more of sensors of a computing device can be used to determine the device context and present an incoming notification based on the device context, such as in a manner likely to cause the user of the device to become aware of the notification but not to unduly disturb the user or others within the vicinity of the user. The device context may include information about the state of the computing device with respect to the user as determined by the sensors of the device, such as a distance between the computing device and the user; a position and/or orientation of the device with respect to the user; whether the user is determined to be gazing at a display element of the device; whether the device can be heard or otherwise be sensed by the user (e.g., touchable, graspable); whether the device is located within a user's pocket or a user's purse, bag, backpack, holster, fanny pack, etc.; and other determinable and/or quantifiable characteristics of the device with respect to the user. The device context may also include information about the state of the device itself as measured by the sensors of the device, such as motion of the device, position and/or orientation of the device with respect to a frame of reference other than the user (e.g., such as another user, object, or location), a geolocation of the device, an amount of pressure being applied to the device, and other determinable and/or quantifiable characteristics of the device. Further, the device context can include information about a state of the environment in which the device is located as set forth by the device sensors, such as an amount of ambient noise or light, atmospheric pressure, temperature, and other determinable and/or quantifiable characteristics of the environment.

In some embodiments, data from multiple sensors or other input elements of the computing device can be aggregated to obtain a more accurate and/or detailed understanding of the context of the device. For example, captured image data can be analyzed to determine that the user is not looking at the display element of the device, motion and orientation data captured by inertial sensors can be analyzed to determine that the movement of the device corresponds to a user's gait, and touch sensor data can be analyzed to determine that the user is grasping the device. An indication of a notification can be presented to the user based on the device context. In this example, the device can vibrate in the event of an incoming notification because it is determined that it is likely the user is walking with the device in her hand but not looking at the device. Device vibration is likely to inform the user of the notification due to the physical contact between the device and the user yet would not be obtrusive to the user or others around the user. On the other hand, if analysis of the motion and orientation data of the device determines that device movement corresponds to a user's gait and the touch sensor data indicates that no user is touching the device, it may be assumed that the device is in a pocket or bag of a walking user. In this situation, an audio signal may be more effective in attracting the user's attention than a vibration because of the lack of direct contact between the device and the user.

In some embodiments, a user can customize the manner of presenting indications of notifications received to the device in various ways. For example, the user can associate notifications sent from a family member with a particular ringtone, vibration pattern, flashing light pattern, or some combination thereof. As another example, the user can configure the device to present a notification from a business contact within a modal window, pop-up window, dialog box or other user interface requiring user interaction, such as pressing an "OK" or "Ignore" button, before returning control to a user application running on the device prior to receiving the notification. As yet another example, a default configuration for a device may be to present all notifications as toast notifications that are displayed on screen for ten seconds but the user may reconfigure the device to present notifications corresponding to instant messages for only three seconds.

Various other functions and advantages are described and suggested below in accordance with the various embodiments.

FIG. **1**A illustrates an example situation **100** of a user **102** operating a computing device **104** that supports context-aware notifications. Although a portable computing device (e.g., a smart phone, tablet, or portable media player) is shown that can be held in a user's hand, it should be understood that other types of computing devices can utilize aspects of the various embodiments as should be apparent in light of the teachings and suggestions contained herein. The computing device **104** in this example includes a camera **106** positioned on the device such that at least a portion of a user, such as user **102**, operating the computing device **104** is captured by camera **106** when the user is within the field of view **112** of the camera. In this example, camera **106** comprises a digital camera incorporating a CMOS image sensor. In other embodiments, a camera of a device can incorporate other types of image sensors (such as a charged couple device (CCD)) and/or can include multiple cameras, including at least one wide-angle optical element, such as a fish eye lens, that enables the camera to capture images over a wide range of angles, such as 180 degrees or more. Further, each camera can comprise a digital still camera, configured to capture subsequent frames in rapid succession, or a video camera able to capture streaming video. In still other embodiments, a computing device can include other types of imaging elements. such as ambient light sensors, infra-red (IR) sensors, and other optical, light, imaging, or photon sensors.

The example device **104** also includes a display screen **108** at the front of the device, on a same surface as the camera **106**. It should be understood that, while the components of the example device are shown to be on a "front" of the device, there can be similar or alternative components on the "top," "side," or "back" of the device as well (or instead). Further, directions such as "top," "side," and "back" are used for purposes of explanation and are not intended to require specific orientations unless otherwise stated. The display screen **108** is a touchscreen comprising a plurality of capacitive touch sensors and capable of detecting the user's fingertip touching points of the screen as input for the device. In other embodiments, the display element may implement a different touch technology (e.g. resistive, optical, ultrasonic) or may not be capable of detecting a user's touch at all. The computing device **104** also includes one or more microphones **110** or other audio capture devices capable of capturing audio data, such as words spoken by the user **104** of the device or ambient sound in the vicinity of the device. In this example, the microphone **110** is placed on the same side of the device **100** as the display screen **108**, such that the microphone **110** will typically be better able to capture words spoken by a user of the device. In at least some embodiments, the microphone can be a directional microphone that captures sound information from substantially directly in front of the device, and picks up only a limited amount of sound from other directions, which can help to better capture words spoken by a primary user of the device. In other embodiments, a computing device may include multiple microphones to capture 3D audio. In at least some embodiments, a computing device can also include an audio output element, such as internal speakers or one or more ports to support peripheral audio output devices, such as headphones or loudspeakers.

In the example situation **100**, the user **104** can be seen viewing the display screen **108** of the computing device **102**. The user may be interacting with a user application when the device receives a notification from another computing device (not shown). In other embodiments, notifications may be received from the device itself such as a calendar application configured to send a notification to the user to remind the user of an upcoming event or appointment. Upon receiving the notification, the device **102** is configured to activate the camera **106** to capture image data of subject matter within the field of view **112** of the camera. The device then analyzes the image data to determine whether the user is looking at the display screen **108**. The device may use a facial detection algorithm that attempts to recognize any human face in the captured image data, or the device can employ a more complex pupil detection algorithm that attempts to locate the position of the user's pupils and determine whether the user's line of sight is aligned with the display **108**. In some embodiments, the device may be able to recognize and differentiate various users and retrieve user preferences for a recognized user. When it is determined that the user **104** is viewing the display screen **108**, the device presents a graphical element **114** on the display to inform the user of receipt of the notification.

Notifications are a feature of many operating systems that allow a user application or platform software to keep a user informed about events relating to the application or plat-

form. On certain platforms, notifications are implemented as a lightweight service that handles queuing of messages from an application provider and propagation of the messages to a specific device or multiple devices. A user device may maintain a persistent network connection to the notification service, allowing the notification service to deliver any new notifications promptly to a user application or platform of the device. Likewise, an application provider may maintain a persistent connection to the notification service for similar reasons. A user application may be required to subscribe or register to receive notifications to the notification service. When an event relating to the user application or platform occurs, the application provider or platform provider sends a notification to the notification service (e.g., server to server) and the notification service delivers the notification to the intended recipient device (e.g., server to client). Such a framework is sometimes referred to as a "push" architecture, which reverses the client-server model by having a server initiate a transaction instead of having a client request for information from the server. In certain embodiments, the user application may instead use a traditional "pull" architecture and periodically poll a server for new information. However, a "pull" approach may be less advantageous because it may require the user application to execute in the background, which can use more processing resources and power than desirable. In still other embodiments, notifications may be generated by the device or software running on the device itself without necessarily requiring network communication. For example, system alerts such as low battery power or poor network connectivity or user applications such as alarm clocks, schedulers, and the like may also be presented to the user as notifications.

A notification service may permit an application provider to specify how a notification is to be presented to a user device, such as a "badge notification, "toast notification", "banner notification", "in-line notification", "notification area icon", or similar user interface on a display of the user device. A "badge notification" can refer to a counter that is displayed alongside an application icon that may indicate to the user a number of events occurring since the user last interacted with the application, a number of actions required to be taken by the user, a number of unread communications, and the like. A "toast notification" can refer to a dialog box or modal window that is displayed at the foreground and pushes a currently running application to the background. Some user interaction may be required to return control to the running application, such as pressing an "OK" or "IGNORE" button. A "banner notification" can refer to a user interface element that is typically displayed at a top or bottom of the display of a device (but can be displayed anywhere) and may include preview information such as a photograph of the user sending the underlying message corresponding to the notification, a truncated portion of the underlying message, the user application associated with the notification, etc. The banner may be displayed for a limited period of time, such as ten seconds, before the banner ceases to be displayed. A user interaction, such as tapping or swiping the banner may expand the banner notification to display the entirety of the underlying message. The expanded banner may also enable other user interactions, such as tapping on the notification to activate the user application associated with the notification (or bring the user application to the foreground). As another example, the notification may comprise a calendar event and expanding the banner notification may provide a "snooze" interaction enabling the user to cause the notification to be re-sent to the device after a period of time, such as fifteen minutes. An in-line notification can refer to a notification that is displayed in-line with a currently running user application wherein the user may interact with both the notification and the user application. Approaches for providing in-line notifications are discussed in co-pending U.S. patent application Ser. No. 13/627,291, filed Sep. 26, 2012, entitled "Inline Message Alert," which is hereby incorporated by reference herein. A "notification area icon" may refer to a toolbar icon, system tray icon, status bar icon, or similar user interface that is displayed upon receipt of a notification. Tapping or selecting the icon can launch the user application (or bring the application to the foreground) corresponding to the notification.

Notifications are often employed by communication-related user applications, such as a telephony application, voicemail, email, Short Message Service (SMS) text messaging, instant messaging, or social networking, wherein an application provider will send a user a notification in response to a new communication. Notifications are also commonly utilized by applications that publish frequently updated content, such as news, weather, stock market, or sports applications, Rich Site Summary (RSS) feeds, blogs, or social networking applications. Notifications can also be used by online banking or other financial applications to report the financial transactions made to the user's account, games to apprise the user of events in the gaming world, scheduling and calendar applications to remind the user of upcoming events, etc. An operating system and user applications may also use notifications to inform the user of software updates or system status.

FIG. **1**B illustrates an example situation **150** wherein the user **102** moves from his current location and leaves the computing device **104** behind. At substantially the same moment the user is leaving, the device **104** receives a notification. The camera **106** is again activated to capture image data of the scene in front of the camera. In this example, the camera is positioned such that the back of the user is within the field of view of the camera when the camera is triggered. From the captured image data, the device can detect the back of the user and determine that the user is proximate to the device but that the user is not looking at the display screen **108**. The device **104** subsequently emits a low or intermediate ringtone or other audio to apprise the user of the device's receipt of the notification. In other embodiments, a device may be configured to vibrate when the user is determined to be proximate to the device but not holding the device or looking at the display screen of the device. In other situations where no user can be detected from captured image data, the device **102** may be configured to emit a ringtone or other audio of a higher volume.

The example situation **100** of FIG. **1**A describes one approach for determining whether a user is proximate to a computing device—analyzing image data to detect the presence of the user within the image data. Alternatively, or in addition, user proximity to the device can also be determined using one or more proximity sensors. A proximity sensor typically operates by emitting an electromagnetic field or a beam of electromagnetic radiation and detecting changes in the field or return signal. Proximity sensors can be implemented using capacitive, optical, or ultrasonic sensing technology, structured light, infra-red, and/or laser transceiving systems, as well as other approaches known to those of ordinary skill in the art. In one embodiment, a proximity sensor may project a known pattern of infra-red light (e.g., grid) using one or more infra-red emitters and a user can be determined to be proximate to the device if deformation of

the pattern of infra-red light sensed by one or more infra-red detectors corresponds to the shape of the user. In some embodiments, one or more touch sensors can be used at least in part to determine user proximity. For example, a device may include a touchscreen and user interaction with the touchscreen would provide an indication of user proximity. In other embodiments, touch-sensitive materials or components may be dispersed at various locations of a computing device such that the measurements obtained by these touch-sensitive materials or components could indicate whether the user is proximate to the device. In still other embodiments, inertial sensors can detect movement of the device and such movement may correspond to distinct user movement, such as a user gait or a user swinging the device in hand or in a bag. In yet other embodiments, a user's voice can be captured by one or more microphones and the decibel level of the user's voice can be analyzed to determine user proximity to the device. Numerous other approaches can be utilized for determining whether a user is proximate to the device may be utilized and are suggested by the disclosure and teachings provided herein.

Systems and approaches in accordance with various embodiments are able to determine a context of a device using the various sensors of the device and present an indication of an incoming notification based on the determined context. In various embodiments, a computing device may include one or more cameras, microphones, global positioning system (GPS) components, cellular components, Wi-Fi components, Bluetooth® device, radio-frequency (RF) devices, near-field communications (NFC) components, proximity sensors, distance sensors, depth sensors, ambient light sensors, barometers, altimeters, accelerometers, magnetometers, gyroscopes, inclinometers, thermal sensors, touch sensors, pressure sensors, optical sensors, infra-red transceivers, laser transceivers, ultrasonic transceivers, and/or other sensors, transceivers, and mechanisms that can be used to receive a notification from one or more other electronic devices and to determine the device context. In various embodiments, a computing device may include one or more displays, speakers, vibration actuators or mechanisms, uni-colored or multi-colored light-emitting diodes, and/or other output elements that can be used to apprise the user of receipt of the notification.

In various embodiments, a manner of presenting a notification to a user can be determined based on a gaze direction of a user. For example, a visual notification such as a badge, banner, toast, flashing LED pattern, etc. can be presented to the user in lieu of an audio signal or vibration pattern when the user is determined to be gazing towards a display element of a device. In order to determine the gaze direction of a user, a device in at least some embodiments has to determine the relative position of the user relative to the device, as well as dimensions or other aspects of the user at that position. FIG. **2**A illustrates an example **200** wherein images are captured and analyzed to determine the relative positions of the user's head and the user's eyes. In a system wherein the algorithm is able to differentiate the user's pupils, the system can also utilize the relative position of the pupils with respect to the eye position. For example, FIG. **2**B illustrates a case where the user is looking "left" (or to the user's "right"), such that a center point of each user's pupil is to the left (in the image) of the center point of the respective eye. Similarly, FIG. **2**C illustrates a case where the user is looking "up." As can be seen, the positions of the pupils have moved above a center point of the eyes. The position of the pupils can change without the user moving his or her head. Thus the system may be able to, in some embodiments, detect a glance without a change in head position. A system in accordance with one embodiment can take advantage of such information by presenting notifications in a suitable manner to the user.

FIGS. **3**A and **3**B illustrate an example situation **300** of a user **302** with a computing device **304** that supports context-aware notifications and an example situation **350** of a user **352** with a computing device **354** that supports context-aware notifications, respectively. In the FIG. **3**A, the device **304** has been placed in the pants pocket of the user **304** while in FIG. **3**B, the device **354** is kept in a purse or bag of the user **352**. At certain moments, the devices may each receive a notification upon which each device attempts to determine its context to provide an appropriate indication of the notification to its user. Each of the devices **304** and **354** may include an imaging element, such as a camera, that is first used to determine that the users **302** and **352** are not looking at their respective devices. The devices may then determine that the users are not touching their respective devices via a touchscreen and/or other materials or sensors located on the sides of the respective devices where a user is expected to hold the device. The touch sensitive material can include any appropriate material or component, such as multi-touch force-sensitive resistive sensors, capacitive sensors, optical sensors, resistive sensors, pressure sensors, and the like. One specific touch sensitive component can include an interpolating force-sensitive resistor (IFSR) array touch sensor. By utilizing resistive and capacitive input and analyzing and comparing the two, it becomes possible to detect near-touches, detect light touches, and accurately characterize touches, among other such options. Furthermore, an IFSR array allows for measuring the pressure exerted by a touch on the sensor. An example IFSR array comprises two layers. A first layer incorporates columns of electrodes and a second layer comprises rows of electrodes. These layers are disposed generally perpendicular to one another, such that a grid pattern is formed. A resistive material fills gaps between the electrodes within the layers and acts as a linear resistor. When a user pushes upon the array, the resistance at various intersections between the rows and columns changes. Because of the linear responsiveness of the resistive material, it is possible for a touch controller to interpolate the location of a touch between intersections. Additionally, a magnitude of the applied force is discernible as well. Approaches for determining whether a user is holding or grasping a device is discussed in co-pending U.S. patent application Ser. No. 13/481,249, filed May 25, 2012, entitled "Communication via Pressure Input," which is hereby incorporated by reference herein. The devices may then determine that they are being kept close to the user based on analysis of motion and orientation data captured by inertial sensors of the respective devices corresponding to a user's gait. In various embodiments, a device may emit a low to intermediate audio signal and/or vibrate to apprise the user of the device's receipt of a notification when it is determined that the device is proximate to the user.

In at least some embodiments, a computing device may be configured to further differentiate between when the device is in close contact with a user such that the user may be likely to feel device vibration versus when the device is not close enough with respect to the user such that the user may not likely be able to feel device vibration. For example, in the situation **300** illustrated in FIG. **3**A, the device **302** is located in the pants pocket of the user **304** such that the device is in close enough contact that the user may be likely to feel the device vibrating. In contrast, in the situation **350** illustrated in FIG. **3**B, the device **352** can be seen in a purse

hanging away from the body of the user **354** such that the user **354** may be unlikely to feel the device **352** vibrating. In one embodiment, a computing device may include one or more thermal sensors that can be used to assist in distinguishing between device placement in close enough proximity that the user is likely to feel device vibration versus device placement being too far from the user or there being too many layers of insulation between the user and device such that the user is unlikely to feel device vibration. For example, a device may have a contactless thermal sensor located on each of a front and back surface of a computing device. When the device is placed in a user's pocket or bag, the thermal sensor located on a surface facing away from the user may measure a first temperature and the thermal sensor located on a surface facing the user may measure a second temperature. It is well known that the average temperature of the human body is 98.6° F.±1.0° F. (37.0° C.±0.5° C.). If the ambient temperature is less than 90° F. (about 32° C.), a thermal sensor facing the user may read a temperature higher than the ambient temperature due to proximity of the device to the user. When the difference between the two temperatures exceeds a threshold value, it may be assumed that the device is in close enough contact with the user such that the user may be able to feel device vibration. In such a situation, it may be preferable to inform the user of the notification via device vibration rather than an audio signal. When the difference between the two temperatures is below the threshold value, it can be assumed that the user may be too far from the device to feel device vibration and an audio signal can be generated to inform the user of an incoming notification. In an embodiment with one thermal sensor, the ambient temperature can be retrieved from a weather service based on the device's location and can be compared to a reading of the thermal sensor to approximate user proximity to the device.

In another embodiment, motion and orientation data can be further analyzed to determine whether a device is located in a user's pocket or a user's bag. For example, when the device is located in a user's pocket, the device is placed such that either the front surface or the back surface of the device is facing the user, the length of the device (e.g., y-axis) is parallel to the user's body, and the width of the device (e.g., x-axis) is perpendicular to the user's body. The device will be closely aligned with the user's leg such that rotational velocity can be measured along the y-z plane of the device that meets threshold values indicating that motion is due to the user's leg movement. In contrast, when a device is placed in a purse or backpack, rotational velocity may fall outside of the threshold values or is otherwise negligible such that motion and orientation data of the device can differentiate when the device is located in a user's pocket versus when the device is located in a purse or backpack. In one embodiment, when the motion and orientation data indicates that the device is more likely to be located in a user's pocket, the device can vibrate upon receipt of a notification. When the motion and orientation data indicates that the device is more likely to be located in a purse or bag, the device can emit an audio signal upon receipt of a notification.

FIGS. **4**A and **4**B illustrate examples of computing devices that support context-aware notifications in accordance with various embodiments. In the example situation **400** of FIG. **4**A, a user **404** can be seen operating a laptop computer as a portable computing device **402** is situated next to the user. The user is studying in a library and this environment typically requires patrons to remain quiet and turn off portable computing devices or at least mute audio for such devices. For conventional devices, the user may be required to manually change the settings of his phone to turn off a telephone ringer. Further, a computing device's telephone system is not necessarily linked to the device's notification system, and the user may also be required to manually change the settings for his notification system to prevent the device from emitting audio signals upon receiving a notification. More likely than not, however, the user may forget to change the settings for the notification system. Upon receiving a notification to the device, the device may emit an audio signal that could disturb the user and/or others located around the user. In the example situation of **400**, however, the device determines its context and causes the device to vibrate instead of emitting an audio signal. In addition, the user may not be required to manually change the settings for his device to deactivate a telephone ringer or audio signals for a notification system. In various embodiments, a device may be able to determine its location from GPS; a cellular phone network system; an NFC system; other short-range beacon systems based on Wi-Fi, RF, IR, Bluetooth®, and other such approaches known to those of ordinary skill in the art. In certain embodiments, image data can be captured and matched against an image database to recognize a user's current specific location or a type of location of the user's current location. For example, a device (or the device in communication with another system) analyzing the captured image data corresponding the situation **400** may recognize that the user is located in a library based on a plurality of bookshelves within the captured image data. In other embodiments when the captured image data includes textual information, such as an address or a name of a location, the textual information can be recognized using one or more optical character recognition (OCR) engines and the recognized textual information can be used to determine the location. Upon determination of the location, the device may recognize that it would be inappropriate to emit audio signals at the location and inform the user of the notification in an appropriate manner, such as by vibrating the device, displaying a visual indicator on a display element, flashing LEDs, or similar such approaches.

In some embodiments, certain types of locations may be designated as "quiet zones," such as libraries, places of worship, movie theaters, schools, etc. When a device determines that it is located at such a location, it can automatically reconfigure itself to vibrate instead of ringing upon receipt of a telephone call and/or vibrate, display a visual indicator on a display element, and/or flash LEDs upon receipt of a notification instead of ringing or emitting other audio signals. Similarly, some types of locations may be designated as "noisy zones," such as bars, clubs, sports arenas or stadiums, etc. At such locations, a device may be automatically reconfigured to vibrate upon receipt of a telephone call or a notification because ambient sound may be so loud as to render audio signals ineffective in obtaining the user's attention. In at least some embodiments, a device may use a microphone to capture ambient sound, determine a decibel level of the ambient sound, and present an indication of the notification based on the decibel level. For example, the device may emit an audio signal that is greater than the decibel level of the ambient sound in one embodiment. In another embodiment, a device may vibrate instead of generating an audio signal based on the determined decibel level.

In various embodiments, a device may be configured to present indications of notifications based on location. For example, a device may present an indication of a location based on certain locations being designated "quiet zones" or

"noisy zones." FIG. **4**B illustrates an example of such an approach. In the example situation **450** of FIG. **4**B, a computing device **404** can be seen displaying a street map on a display screen **408** of the device. In this example, the device **402** is displaying locations on the display screen **408** at which the device is operated in a quiet mode wherein the device vibrates upon receiving a telephone call and vibrates, displays a visual indicator, emits a flashing light pattern, etc., upon receiving a notification. In particular, a device determined to be located at a first location **452** corresponding to a place of worship, a second location **454** corresponding to a movie theater, or a third location **456** corresponding to a library may be operated in "quiet" mode. In some embodiments, a user interface enabling a user to select a location as a "quiet zone" may further enable the user to designate all locations corresponding to the type of that location as "quiet zones," e.g., all places of worship, libraries, and movie theaters may be designated as "quiet zones" at once. "Noisy zones" can be designated using a similar approach.

As mentioned, presentation of indications of notifications may be customized based on senders of the underlying communications corresponding to the notifications and/or by the underlying software such as by user application or operating system. The manner of presenting notifications may be visual (e.g., flashing of LEDs, displaying graphical elements on a display screen), aural (e.g., ringtones), or tactile (e.g., vibration patterns). The manner of presenting notifications may also be based on different patterns and/or intensity levels. Underlying communications may include emails, voicemails, SMS text messages, instant messages, social network status updates, and similar types of communications. Senders of such communications may be associated with certain ringtones, vibration patterns, flashing light patterns, and/or visual indicators on a display element such that the user can become immediately informed of the sender of the underlying communication corresponding to a notification, and respond accordingly. Likewise, underlying user applications or the device's operating system may also correspond to certain notifications, and presentation of the indications of such notifications may be specified, by the user, the application provider, or the device manufacturer. Ringtones may refer to the tone or sound or pattern of tones or sounds (e.g., song notes) made by the computing device in response to receiving a telephone call or notification. Vibration patterns may refer to the vibrations caused by actuators, motors, and other vibration mechanisms incorporated in a computing device. Different vibration patterns can be generated by varying the length and/or intensity of vibrations, and the time between vibrations. In at least some embodiments, a device may incorporate a plurality of vibration actuators or other vibration mechanisms, such as an actuator located along each of an edge of the device. In such devices, vibration patterns may also be varied according to the location of the actuator or other vibration mechanism, such as vibrating clockwise or counterclockwise or alternating between vibrations of top-bottom and left-right pairs of actuators or vibration mechanisms. Flashing light patterns may refer to the flashing of one or more LEDs incorporated by a computing device. Flashing of LEDs can be varied by the length of time an LED is activated and deactivated as well as intensity of the LED. Some LEDs may be capable of flashing different colors, and flashing light patterns can also be varied according to color. Visual indications of notifications can include badges, toasts, banners, in-line interfaces, notification area icons, and other such interfaces displayed on a display element.

FIG. **5** illustrates an example process for presenting context-aware notifications in accordance with an embodiment. It should be understood that, for any process discussed herein, there can be additional, fewer, or alternative steps performed in similar or alternative orders, or in parallel, within the scope of the various embodiments unless otherwise stated. In this example, the process is initiated in response to a computing device receiving a notification **502**. As mentioned, a notification may correspond to a communication, such as a telephone call, voicemail, email, text message, instant message, or social network status update. A notification may also correspond to newly published content, such as from news, weather, stock market, or sports applications, RSS feeds, blogs, or social networking applications. Further, notifications may inform users of new transactions to user's bank or other financial account, gaming events in a video game, scheduling events, software updates, etc. Upon receipt of the notification, the device may use a camera located on a same surface as a display element of the device to capture image data **504** of subject matter within the field of view the camera. The image data may be analyzed **506** to determine whether a user is present within the image data **508**. If a user is located within the image data, the image data may be further analyzed to determine whether the user is gazing towards or viewing the display element **510**. If the user is gazing towards or viewing the display element, a visual indication may be displayed on the display element to inform the user of receipt of the notification **512**. The visual indication may include a badge, toast, banner, in-line notification, a notification area icon, or other such graphical element. If the user is present within the image data but not gazing towards or not viewing the display element, the device can emit a first audio signal of a low to intermediate volume **514** to alert the user of receipt of the notification. If the user is not present within the image data at all, the device may emit a second audio signal of a higher volume **516** to apprise the user of receipt of the notification. In other embodiments, the device may vibrate to inform the user of receipt of the notification when the user is present within the image data but is determined not to be gazing towards or viewing the display element.

FIG. **6**A illustrates an example process for presenting context-aware notifications in accordance with various embodiments. In this example, the process is initiated in response to a computing device receiving a notification **602**. Upon receiving the notification, the device may use one or more sensors of the device to determine a context of the device **604**. Based on the determined context, the device presents an indication of receipt of the notification **606**. Examples of one approach of determining a context of a device is illustrated in FIG. **6**B. Although illustrated sequentially here, any of these steps can be used (or not used) to determine device context as in step **604** of FIG. **6**A in any particular order or in parallel in various embodiments. As one example, the device may first determine its geographic location **652** to determine whether the location is associated with a particular device behavior. As mentioned, some locations may be designated "quiet zones" wherein receipt of a notification is limited to a visual indicator (e.g., badge, toast, banner, icon, etc. on a display element or flashing LEDs) or tactile indicators (e.g., vibrations). In other situations, a location may be designated a "noisy zone" wherein an incoming notification may be presented using an audio signal louder than the measured level of ambient sound or via vibration. The device behavior may be specified by the user, application provider, service provider, or device manufacturer.

If the location cannot be determined or if there is no particular device behavior specified for the location or the type of the location, the device may capture image data and analyze whether a user is gazing towards or viewing a display element of the device **654** according to the captured image data. If the user is determined to be gazing towards or viewing the display element, an indication of receiving the notification may be limited to a visual indicator. If the user is determined to be within the captured image data but not gazing towards or looking at the device, it is assumed that the user is within the vicinity of the device and the device may vibrate or emit a low to intermediate audio signal to capture the user's attention. If the user is not captured by the camera of the device, touch sensor data can be analyzed to determine whether the user is holding the device **656**. A device may include a touchscreen that covers the entirety of a front surface of the device. When the user is grasping the device, the touch sensor data of the touchscreen may be analyzed to determine that the user is holding the device by the front of the device (e.g., touch points correspond to the user's palm) or that the user is holding the device by the back of the device (e.g., touch points correspond to user's fingers along the edges of the touchscreen). In another embodiment, a device may incorporate touch, proximity, and/or pressure sensors along the sides of the device to determine whether the user is holding the device.

If it is determined that the user is not holding the device, other sensor data may be captured to determine a context of the device. For example, motion and/or orientation data can be acquired from one or more inertial sensors **658**. The motion/orientation data may indicate that the device is located within a moving vehicle. In one embodiment, the device may try to sync with the vehicle's stereo system via Bluetooth® and present an indication of a received notification via an audio signal through the car's stereo system. In another embodiment, the motion/orientation data may correspond to a user's gait. The device may attempt to differentiate whether the device is located in a user's pocket or a user's bag as she is walking **660**. As mentioned, the motion and orientation of the device will include a rotation along the y-z plane as the user is walking when it is located in the user's pocket. When the device is placed in a purse or bag as the user is walking, such rotation is minimal or non-existent. By measuring the rotation velocity of the device as the user is walking, the device can differentiate between placement in a user's pants pocket versus a user's purse or bag. When the device is determined to be located in a user's pants pocket, the device can vibrate to inform the user of an incoming notification. In another embodiment, one or more pressure sensors can be used to measure an amount of pressure or force being applied to the device. In one embodiment, a device may include at least a first pressure sensor that measures force applied to a front surface of the device and a second pressure sensor that measures force applied to a back surface of the device. The device can differentiate from when it is located in a user's pocket based and when it is located in a a bag or backpack based on the readings from the pressure sensors. In some embodiments, a device may be capable of determining force or pressure being applied to each surface of the device. In yet another embodiment, thermal sensors on opposing faces of a computing device can be used to determine whether the device is in proximity to the user's body. Various other approaches can be used to determine a device context based on the disclosure and teachings provided herein.

FIG. **7** illustrates an example computing device **700** that can be used to perform approaches described in accordance with various embodiments. In this example, the device includes at least one camera **706** located on a same front surface of the device as a display element **708**, and enabling the device to capture images in accordance with various embodiments. The computing device also includes a speaker **710** for outputting an audio signal and an array of multi-colored (red, green, blue) LEDs **712** that can be seen from both the front surface and the back surface of the computing device. A processor (not shown) of the device can control when each of the LEDs are activated and deactivated, a color that an LED emits, and an intensity at which the LED is emitted. From the back surface of the computing device, the locations of vibration actuators **714** are outlined. The processor of the device can control activation and deactivation of each of the actuators and the intensity of vibration of each of the actuators.

FIG. **8** illustrates a logical arrangement of a set of general components of an example computing device **800** such as the device **700** described with respect to FIG. **7**. In this example, the device includes a processor **802** for executing instructions that can be stored in a memory device or element **804**. As would be apparent to one of ordinary skill in the art, the device can include many types of memory, data storage, or non-transitory computer-readable storage media, such as a first data storage for program instructions for execution by the processor **802**, a separate storage for images or data, a removable memory for sharing information with other devices, etc. The device typically will include some type of display element **808**, such as a touchscreen, electronic ink (e-ink), organic light emitting diode (OLED), liquid crystal display (LCD), etc., although devices such as portable media players might convey information via other means, such as through audio speakers. In at least some embodiments, the display screen provides for touch or swipe-based input using, for example, capacitive or resistive touch technology. As mentioned, the device in many embodiments will include one or more cameras or image sensors **806** for capturing image or video content. A camera can include, or be based at least in part upon any appropriate technology, such as a CCD or CMOS image sensor having a sufficient resolution, focal range, viewable area, to capture an image of the user when the user is operating the device. An image sensor can include a camera or infrared sensor that is able to image projected images or other objects in the vicinity of the device. Methods for capturing images or video using a camera with a computing device are well known in the art and will not be discussed herein in detail. It should be understood that image capture can be performed using a single image, multiple images, periodic imaging, continuous image capturing, image streaming, etc. Further, a device can include the ability to start and/or stop image capture, such as when receiving a command from a user, application, or other device. The example device can similarly include at least one audio component, such as a mono or stereo microphone or microphone array, operable to capture audio information from at least one primary direction. A microphone can be a uni- or omni-directional microphone as known for such devices.

The computing device **800** includes at least one capacitive component or other proximity sensor, which can be part of, or separate from, the display assembly. In at least some embodiments the proximity sensor can take the form of a capacitive touch sensor capable of detecting the proximity of a finger or other such object as discussed herein. The computing device also includes various power components **814** known in the art for providing power to a computing device, which can include capacitive charging elements for

use with a power pad or similar device. The computing device can include one or more communication elements or networking sub-systems **816**, such as a Wi-Fi, Bluetooth®, RF, wired, or wireless communication system. The device in many embodiments can communicate with a network, such as the Internet, and may be able to communicate with other such devices. In some embodiments the device can include at least one additional input device **818** able to receive conventional input from a user. This conventional input can include, for example, a push button, touch pad, touchscreen, wheel, joystick, keyboard, mouse, keypad, or any other such device or element whereby a user can input a command to the device. In some embodiments, however, such a device might not include any buttons at all, and might be controlled only through a combination of visual and audio commands, such that a user can control the device without having to be in contact with the device.

The device **800** also can include one or more orientation and/or motion sensors **812**. Such sensor(s) can include an accelerometer or gyroscope operable to detect an orientation and/or change in orientation, or an electronic or digital compass, which can indicate a direction in which the device is determined to be facing. The mechanism(s) also (or alternatively) can include or comprise a global positioning system (GPS) or similar positioning element operable to determine relative coordinates for a position of the computing device, as well as information about relatively large movements of the device. The device can include other elements as well, such as may enable location determinations through triangulation or another such approach. These mechanisms can communicate with the processor **802**, whereby the device can perform any of a number of actions described or suggested herein.

In some embodiments, the device **800** can include the ability to activate and/or deactivate detection and/or command modes, such as when receiving a command from a user or an application, or retrying to determine an audio input or video input, etc. For example, a device might not attempt to detect or communicate with devices when there is not a user in the room. If a proximity sensor of the device, such as an IR sensor, detects a user entering the room, for instance, the device can activate a detection or control mode such that the device can be ready when needed by the user, but conserve power and resources when a user is not nearby.

In some embodiments, the computing device **800** may include a light-detecting element that is able to determine whether the device is exposed to ambient light or is in relative or complete darkness. Such an element can be beneficial in a number of ways. For example, the light-detecting element can be used to determine when a user is holding the device up to the user's face (causing the light-detecting element to be substantially shielded from the ambient light), which can trigger an action such as the display element to temporarily shut off (since the user cannot see the display element while holding the device to the user's ear). The light-detecting element could be used in conjunction with information from other elements to adjust the functionality of the device. For example, if the device is unable to detect a user's view location and a user is not holding the device but the device is exposed to ambient light, the device might determine that it has likely been set down by the user and might turn off the display element and disable certain functionality. If the device is unable to detect a user's view location, a user is not holding the device and the device is further not exposed to ambient light, the device might determine that the device has been placed in a bag or other compartment that is likely inaccessible to the user and thus might turn off or disable additional features that might otherwise have been available. In some embodiments, a user must either be looking at the device, holding the device or have the device out in the light in order to activate certain functionality of the device. In other embodiments, the device may include a display element that can operate in different modes, such as reflective (for bright situations) and emissive (for dark situations). Based on the detected light, the device may change modes.

In some embodiments, the device **800** can disable features for reasons substantially unrelated to power savings. For example, the device can use voice recognition to determine people near the device, such as children, and can disable or enable features, such as Internet access or parental controls, based thereon. Further, the device can analyze recorded noise to attempt to determine an environment, such as whether the device is in a car or on a plane, and that determination can help to decide which features to enable/disable or which actions are taken based upon other inputs. If speech or voice recognition is used, words can be used as input, either directly spoken to the device or indirectly as picked up through conversation. For example, if the device determines that it is in a car, facing the user and detects a word such as "hungry" or "eat," then the device might turn on the display element and display information for nearby restaurants, etc. A user can have the option of turning off voice recording and conversation monitoring for privacy and other such purposes.

In some of the above examples, the actions taken by the device relate to deactivating certain functionality for purposes of reducing power consumption. It should be understood, however, that actions can correspond to other functions that can adjust similar and other potential issues with use of the device. For example, certain functions, such as requesting Web page content, searching for content on a hard drive and opening various applications, can take a certain amount of time to complete. For devices with limited resources, or that have heavy usage, a number of such operations occurring at the same time can cause the device to slow down or even lock up, which can lead to inefficiencies, degrade the user experience and potentially use more power. In order to address at least some of these and other such issues, approaches in accordance with various embodiments can also utilize information such as user gaze direction to activate resources that are likely to be used in order to spread out the need for processing capacity, memory space and other such resources.

In some embodiments, the device can have sufficient processing capability, and the camera and associated image analysis algorithm(s) may be sensitive enough to distinguish between the motion of the device, motion of a user's head, motion of the user's eyes and other such motions, based on the captured images alone. In other embodiments, such as where it may be desirable for an image process to utilize a fairly simple camera and image analysis approach, it can be desirable to include at least one orientation determining element that is able to determine a current orientation of the device. In one example, the one or more orientation and/or motion sensors may comprise a single- or multi-axis accelerometer that is able to detect factors such as three-dimensional position of the device and the magnitude and direction of movement of the device, as well as vibration, shock, etc. Methods for using elements such as accelerometers to determine orientation or movement of a device are also known in the art and will not be discussed herein in detail. Other elements for detecting orientation and/or movement can be used as well within the scope of various embodiments

for use as the orientation determining element. When the input from an accelerometer or similar element is used along with the input from the camera, the relative movement can be more accurately interpreted, allowing for a more precise input and/or a less complex image analysis algorithm.

When using a camera of the computing device to detect motion of the device and/or user, for example, the computing device can use the background in the images to determine movement. For example, if a user holds the device at a fixed orientation (e.g. distance, angle, etc.) to the user and the user changes orientation to the surrounding environment, analyzing an image of the user alone will not result in detecting a change in an orientation of the device. Rather, in some embodiments, the computing device can still detect movement of the device by recognizing the changes in the background imagery behind the user. So, for example, if an object (e.g. a window, picture, tree, bush, building, car, etc.) moves to the left or right in the image, the device can determine that the device has changed orientation, even though the orientation of the device with respect to the user has not changed. In other embodiments, the device may detect that the user has moved with respect to the device and adjust accordingly. For example, if the user tilts their head to the left or right with respect to the device, the content rendered on the display element may likewise tilt to keep the content in orientation with the user.

As discussed, different approaches can be implemented in various environments in accordance with the described embodiments. For example, FIG. **9** illustrates an example of an environment **900** for implementing aspects in accordance with various embodiments. As will be appreciated, although a Web-based environment is used for purposes of explanation, different environments may be used, as appropriate, to implement various embodiments. The system includes an electronic client device **902**, which can include any appropriate device operable to send and receive requests, messages or information over an appropriate network **904** and convey information back to a user of the device. Examples of such client devices include personal computers, cell phones, handheld messaging devices, laptop computers, set-top boxes, personal data assistants, electronic book readers and the like. The network can include any appropriate network, including an intranet, the Internet, a cellular network, a local area network or any other such network or combination thereof. Components used for such a system can depend at least in part upon the type of network and/or environment selected. Protocols and components for communicating via such a network are well known and will not be discussed herein in detail. Communication over the network can be enabled via wired or wireless connections and combinations thereof. In this example, the network includes the Internet, as the environment includes a Web server **906** for receiving requests and serving content in response thereto, although for other networks, an alternative device serving a similar purpose could be used, as would be apparent to one of ordinary skill in the art.

The illustrative environment includes at least one application server **908** and a data store **910**. It should be understood that there can be several application servers, layers or other elements, processes or components, which may be chained or otherwise configured, which can interact to perform tasks such as obtaining data from an appropriate data store. As used herein, the term "data store" refers to any device or combination of devices capable of storing, accessing and retrieving data, which may include any combination and number of data servers, databases, data storage devices and data storage media, in any standard, distributed or clustered environment. The application server **908** can include any appropriate hardware and software for integrating with the data store **910** as needed to execute aspects of one or more applications for the client device and handling a majority of the data access and business logic for an application. The application server provides access control services in cooperation with the data store and is able to generate content such as text, graphics, audio and/or video to be transferred to the user, which may be served to the user by the Web server **906** in the form of HTML, XML or another appropriate structured language in this example. The handling of all requests and responses, as well as the delivery of content between the client device **902** and the application server **908**, can be handled by the Web server **906**. It should be understood that the Web and application servers are not required and are merely example components, as structured code discussed herein can be executed on any appropriate device or host machine as discussed elsewhere herein.

The data store **910** can include several separate data tables, databases or other data storage mechanisms and media for storing data relating to a particular aspect. For example, the data store illustrated includes mechanisms for storing content (e.g., production data) **912** and user information **916**, which can be used to serve content for the production side. The data store is also shown to include a mechanism for storing log or session data **914**. It should be understood that there can be many other aspects that may need to be stored in the data store, such as page image information and access rights information, which can be stored in any of the above listed mechanisms as appropriate or in additional mechanisms in the data store **910**. The data store **910** is operable, through logic associated therewith, to receive instructions from the application server **908** and obtain, update or otherwise process data in response thereto. In one example, a user might submit a search request for a certain type of item. In this case, the data store might access the user information to verify the identity of the user and can access the catalog detail information to obtain information about items of that type. The information can then be returned to the user, such as in a results listing on a Web page that the user is able to view via a browser on the user device **902**. Information for a particular item of interest can be viewed in a dedicated page or window of the browser.

Each server typically will include an operating system that provides executable program instructions for the general administration and operation of that server and typically will include computer-readable medium storing instructions that, when executed by a processor of the server, allow the server to perform its intended functions. Suitable implementations for the operating system and general functionality of the servers are known or commercially available and are readily implemented by persons having ordinary skill in the art, particularly in light of the disclosure herein.

The environment in one embodiment is a distributed computing environment utilizing several computer systems and components that are interconnected via communication links, using one or more computer networks or direct connections. However, it will be appreciated by those of ordinary skill in the art that such a system could operate equally well in a system having fewer or a greater number of components than are illustrated in FIG. **9**. Thus, the depiction of the system **900** in FIG. **9** should be taken as being illustrative in nature and not limiting to the scope of the disclosure.

The various embodiments can be further implemented in a wide variety of operating environments, which in some

cases can include one or more user computers or computing devices which can be used to operate any of a number of applications. User or client devices can include any of a number of general purpose personal computers, such as desktop or laptop computers running a standard operating system, as well as cellular, wireless and handheld devices running mobile software and capable of supporting a number of networking and messaging protocols. Such a system can also include a number of workstations running any of a variety of commercially-available operating systems and other known applications for purposes such as development and database management. These devices can also include other electronic devices, such as dummy terminals, thin-clients, gaming systems and other devices capable of communicating via a network.

Most embodiments utilize at least one network that would be familiar to those skilled in the art for supporting communications using any of a variety of commercially-available protocols, such as TCP/IP, OSI, FTP, UPnP, NFS, CIFS and AppleTalk. The network can be, for example, a local area network, a wide-area network, a virtual private network, the Internet, an intranet, an extranet, a public switched telephone network, an infrared network, a wireless network and any combination thereof.

In embodiments utilizing a Web server, the Web server can run any of a variety of server or mid-tier applications, including HTTP servers, FTP servers, CGI servers, data servers, Java servers and business application servers. The server(s) may also be capable of executing programs or scripts in response requests from user devices, such as by executing one or more Web applications that may be implemented as one or more scripts or programs written in any programming language, such as Java®, C, C# or C++ or any scripting language, such as Perl, Python or TCL, as well as combinations thereof. The server(s) may also include database servers, including without limitation those commercially available from Oracle®, Microsoft®, Sybase® and IBM®.

The environment can include a variety of data stores and other memory and storage media as discussed above. These can reside in a variety of locations, such as on a storage medium local to (and/or resident in) one or more of the computers or remote from any or all of the computers across the network. In a particular set of embodiments, the information may reside in a storage-area network (SAN) familiar to those skilled in the art. Similarly, any necessary files for performing the functions attributed to the computers, servers or other network devices may be stored locally and/or remotely, as appropriate. Where a system includes computerized devices, each such device can include hardware elements that may be electrically coupled via a bus, the elements including, for example, at least one central processing unit (CPU), at least one input device (e.g., a mouse, keyboard, controller, touch-sensitive display element or keypad) and at least one output device (e.g., a display device, printer or speaker). Such a system may also include one or more storage devices, such as disk drives, optical storage devices and solid-state storage devices such as random access memory (RAM) or read-only memory (ROM), as well as removable media devices, memory cards, flash cards, etc.

Such devices can also include a computer-readable storage media reader, a communications device (e.g., a modem, a network card (wireless or wired), an infrared communication device) and working memory as described above. The computer-readable storage media reader can be connected with, or configured to receive, a computer-readable storage medium representing remote, local, fixed and/or removable storage devices as well as storage media for temporarily and/or more permanently containing, storing, transmitting and retrieving computer-readable information. The system and various devices also typically will include a number of software applications, modules, services or other elements located within at least one working memory device, including an operating system and application programs such as a client application or Web browser. It should be appreciated that alternate embodiments may have numerous variations from that described above. For example, customized hardware might also be used and/or particular elements might be implemented in hardware, software (including portable software, such as applets) or both. Further, connection to other computing devices such as network input/output devices may be employed.

Storage media and computer readable media for containing code, or portions of code, can include any appropriate media known or used in the art, including storage media and communication media, such as but not limited to volatile and non-volatile, removable and non-removable media implemented in any method or technology for storage and/or transmission of information such as computer readable instructions, data structures, program modules or other data, including RAM, ROM, EEPROM, flash memory or other memory technology, CD-ROM, digital versatile disk (DVD) or other optical storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices or any other medium which can be used to store the desired information and which can be accessed by a system device. Based on the disclosure and teachings provided herein, a person of ordinary skill in the art will appreciate other ways and/or methods to implement the various embodiments.

The specification and drawings are, accordingly, to be regarded in an illustrative rather than a restrictive sense. It will, however, be evident that various modifications and changes may be made thereunto without departing from the broader spirit and scope of the invention as set forth in the claims.

What is claimed is:

1. A system, comprising:

one or more processors;

a display;

one or more cameras;

one or more speakers;

memory including instructions that, upon being executed by the one or more processors, cause the system to:

receive a first notification to the system;

determine, using first image data captured by the one or more cameras, that a first line of sight is directed to the display;

provide visual data associated with the first notification for presentation via the display;

receive a second notification to the system;

determine, using second image data captured by the one or more cameras, that a second line of sight is directed away from the display;

provide first aural data associated with the second notification for presentation via the speaker, the first aural data corresponding to a first volume;

receive a third notification to the system;

determine, using third image data captured by the one or more cameras, that a third line of sight is directed away from the display;

receive proximity information of one or more objects relative to the display;

determine, using the proximity information, that a proximity of the one or more objects exceeds a proximity threshold; and

provide second aural data associated with the third notification for presentation via the speaker, the second aural data corresponding to a second volume greater than the first volume.

2. The system of claim **1**, wherein the instructions further cause the system to:

receive second proximity information of the one or more objects relative to the display; and

determine, using the second proximity information, that a second proximity of the one or more objects is within the proximity threshold,

wherein the first volume is selected for the first aural data based at least in part on the second proximity being within the proximity threshold.

3. The system of claim **1**,

wherein the first aural data further differs from the second aural data based at least in part on at least one of a pattern or a duration of time.

4. The system of claim **1**, further comprising:

a microphone,

wherein the instructions upon being executed further cause the system to:

receive audio data from the microphone; and

determine ambient noise information using the audio data,

wherein the first volume is selected based at least in part on the ambient noise information.

5. The system of claim **4**, wherein the ambient noise information is used to determine that an ambient noise level is below a threshold noise level.

6. The system of claim **4**, wherein the ambient noise information is used to determine that an ambient noise level exceeds a threshold noise level.

7. The system of claim **1**, further comprising:

a first electronic device including the display; and

a second electronic device including at least one of the camera or the speaker.

8. A system, comprising:

one or more processors;

a first electronic device including a display;

one of a second electronic device including a camera and a speaker, or the second electronic device including the camera and a third electronic device including the speaker; and

memory including instructions that, upon being executed by the one or more processors, cause the system to:

receive a first notification to the system;

determine that a line of sight of a user is directed relative to the display based at least in part on first image data captured by the camera;

provide visual data associated with the first notification for presentation via the display;

receive a second notification to the system;

determine that the line of sight is directed away from the display based at least in part on second image data captured by the camera;

provide first aural data associated with the second notification for presentation via the speaker, the first aural data corresponding to a first volume;

receive a third notification to the system;

determine that the line of sight is directed away from the display based at least in part on third image data captured by the camera;

receive proximity information of the user relative to the display;

determine that a proximity of the user exceeds a proximity threshold based at least in part on the proximity information; and

provide second aural data associated with the third notification for presentation via the speaker, the second aural data corresponding to a second volume greater than the first volume.

9. The system of claim **8**, wherein the instructions upon being executed further cause the system to:

determine second proximity information of the user relative to the display; and

determine that a second proximity of the user is within the proximity threshold based at least in part on the second proximity information,

wherein the first volume is selected for the first aural data based at least in part on the second proximity being within the proximity threshold.

10. The system of claim **8**, wherein the first aural data further differs from the second aural data based at least in part on at least one of a pattern or a duration of time.

11. A computer-implemented method, comprising:

receiving a first notification to a system;

determining that a line of sight of a user is directed to a display of the system based at least in part on first image data captured by one or more cameras of the system;

presenting visual data associated with the first notification via the display;

receiving a second notification to the system;

determining that the line of sight is directed away from the display based at least in part on second image data captured by the one or more cameras;

presenting first aural data associated with the second notification via a speaker of the system, the first aural data corresponding to a first volume;

receiving a third notification to the system;

determining that the line of sight is directed away from the display based at least in part on third image data captured by the one or more cameras;

receiving proximity information of the user relative to the display;

determining that a proximity of the user exceeds a proximity threshold based at least in part on the proximity information; and

presenting second aural data associated with the third notification via the speaker, the second aural data corresponding to a second volume greater than the first volume.

12. The computer-implemented method of claim **11**, further comprising:

capturing audio data using a microphone of the system; and

determining an ambient noise level based at least in part on the audio data,

wherein the first volume is selected based at least in part on the ambient noise level being below a threshold noise level.

13. The computer-implemented method of claim **11**, further comprising:

capturing audio data using a microphone of the system; and

determining an ambient noise level based at least in part on the audio data,

wherein the first volume is selected based at least in part on the ambient noise level exceeding the threshold noise level.

14. The computer-implemented method of claim **11**, wherein the camera is incorporated within a first electronic device of the system and the speaker is incorporated within a second electronic device of the system.

15. The system of claim **1**, further comprising:

one or more haptic elements,

wherein the instructions upon being executed further cause the system to:

provide first haptic data associated with the second notification for output via the one or more haptic elements.

16. The system of claim **15**, wherein the instructions upon being executed further cause the system to:

provide second haptic data associated with the third notification for output via the one or more haptic elements,

wherein the first haptic data differs from the second haptic data based at least in part on at least one of a pattern, a duration of time, or an intensity level.

17. The system of claim **8**, further comprising:

a haptic element,

wherein the instructions upon being executed further cause the system to:

provide first haptic data associated with the second notification for output via the haptic element.

18. The system of claim **17**, wherein the instructions upon being executed further cause the system to:

provide second haptic data associated with the third notification for output via the haptic element,

wherein the first haptic data differs from the second haptic data based at least in part on at least one of a pattern, a duration of time, or an intensity level.

19. The computer-implemented method of claim **11**, further comprising:

presenting first haptic data associated with the second notification via one or more haptic elements of the system.

20. The computer-implemented method of claim **19**, further comprising:

presenting second haptic data associated with the third notification for output via the one or more haptic elements,

wherein the first haptic data differs from the second haptic data based at least in part on at least one of a pattern, a duration of time, or an intensity level.

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